U.S. DEPARTMENT OF COMMERCE
National Institute of Standards and Technology

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PUBLICATIONS

FIPS

FIPS PUB 160

FEDERAL INFORMATION PROCESSING STANDARDS PUBLICATION

C

CATEGORY: SOFTWARE STANDARD   SUBCATEGORY: PROGRAMMING LANGUAGE
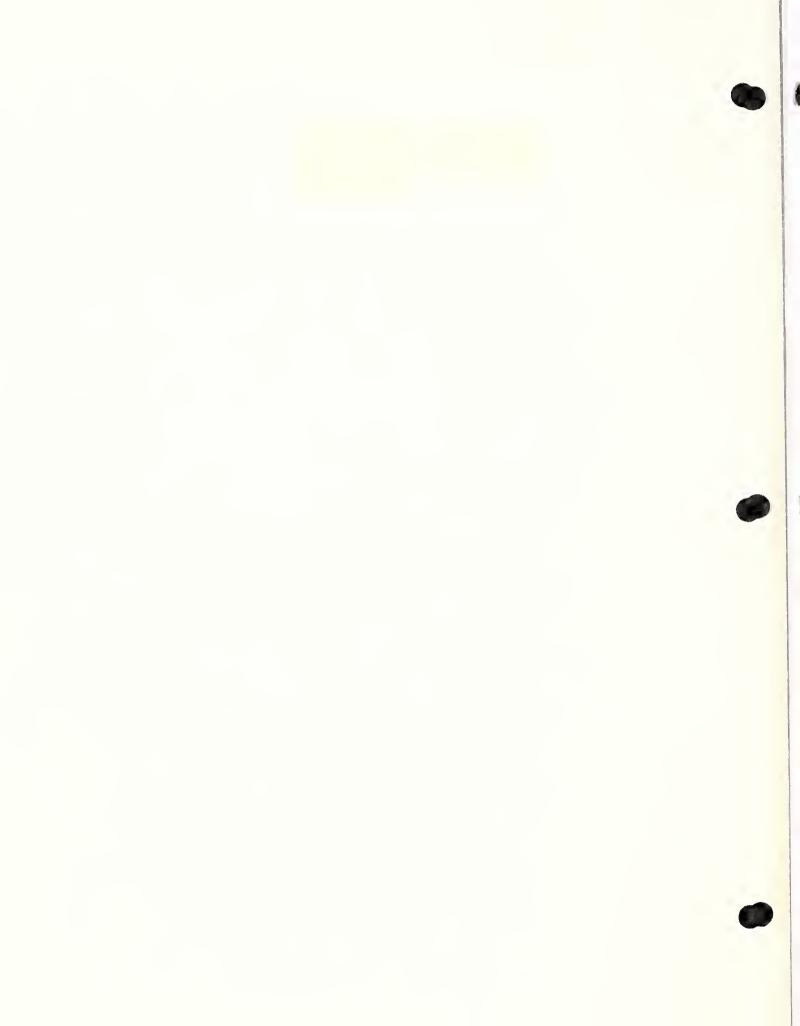
1991 March 13

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Foreword

The Federal Information Processing Standards Publication Series of the National Institute of Standards and Technology (NIST) is the official publication relating to standards and guidelines adopted and promulgated under the provisions of Section 111(d) of the Federal Property and Administrative Services Act of 1949 as amended by the Computer Security Act of 1987, Public Law 100-235. These mandates have given the Secretary of Commerce and NIST important responsibilities for improving the utilization and management of computer and related telecommunications systems in the Federal Government. The NIST through its Computer Systems Laboratory provides leadership, technical guidance, and coordination of Government efforts in the development of standards and guidelines in these areas.

Comments concerning Federal Information Processing Standards Publications are welcomed and should be addressed to the Director, Computer Systems Laboratory, National Institute of Standards and Technology, Gaithersburg, MD 20899.

James H. Burrows, Director
Computer Systems
Laboratory

Abstract

This publication announces the adoption of American National Standard for C, ANSI X3.159-1989, as a Federal Information Processing Standard (FIPS). The American National Standard for C specifies the form and establishes the interpretation of programs written in the C programming language. The purpose of the standard is to promote portability of C programs for use on a variety of data processing systems. The standard is for use by implementors as the reference authority in developing compilers, interpreters, or other forms of high level language processors; and by other computer professionals who need to know the precise syntactic and semantic rules adopted by ANSI.

Key words: C; data processing; Federal Information Processing Standard; information interchange; information processing; programming language; software; standards conformance.

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Processing Standards Publication 160

1991 March 13

Announcing the Standard for

C

Federal Information Processing Standards Publications (FIPS PUBS) are issued by the National Institute of Standards and Technology (NIST) after approval by the Secretary of Commerce pursuant to Section 111(d) of the Federal Property and Administrative Services Act of 1949 as amended by the Computer Security Act of 1987, Public Law 100-235.

1. Name of Standard. C (FIPS PUB 160).

2. Category of Standard. Software Standard, Programming Language.

3. Explanation. This publication announces the adoption of American National Standard for C, ANSI X3.159-1989, as a Federal Information Processing Standard (FIPS). The American National Standard for C specifies the form and establishes the interpretation of programs written in the C programming language. The purpose of the standard is to promote portability of C programs for use on a variety of data processing systems. The standard is for use by implementors as the reference authority in developing compilers, interpreters, or other forms of high level language processors; and by other computer professionals who need to know the precise syntactic and semantic rules adopted by ANSI.

4. Approving Authority. Secretary of Commerce.

5. Maintenance Agency. Department of Commerce, National Institute of Standards and Technology (Computer Systems Laboratory).

6. Cross Index. American National Standard X3.159-1989, Programming Language C.

7. Related Documents.*
    a. Federal Information Resources Management Regulation 201-39, Acquisition of Federal Information Processing Resources by Contracting.
    b. Federal Information Processing Standards (FIPS) Publication 29, Interpretation Procedures for Federal Information Processing Standard Programming Languages.
    c. NBS Special Publication 500-117, Selection and Use of General-Purpose Programming Languages.

8. Objectives. Federal standards for high level programming languages permit Federal departments and agencies to exercise more effective control over the production, management, and use of the Government's information resources. The primary objectives of Federal programming language standards are:

- to encourage more effective utilization and management of programmers by ensuring that programming skills acquired on one job are transportable to other jobs, thereby reducing the cost of programmer retraining;

- to reduce the cost of program development by achieving the increased programmer productivity that is inherent in the use of high level programming languages;

- to reduce the overall software costs by making it easier and less expensive to maintain programs and to transfer programs among different computer systems, including replacement systems; and

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*Refers to most recent revision of FIPS PUBS.

— to protect the existing software assets of the Federal Government by ensuring to the maximal feasible extent that Federal programming language standards are technically sound and that subsequent revisions are compatible with the installed base.

Government-wide attainment of the above objectives depends upon the widespread availability and use of comprehensive and precise standard language specifications.

9. Applicability.

a. Federal standards for high level programming languages are applicable for computer applications and programs that are either developed or acquired for government use. FIPS C is one of the high level programming language standards provided for use by all Federal departments and agencies. FIPS C is suitable for use in programming relating to operating system level software, and applications which require very low level programming constructs that are independent of the system or hardware architecture.

b. The use of FIPS high level programming languages applies when one or more of the following situations exist:

— It is anticipated that the life of the program will be longer than the life of the presently utilized equipment.

— The application or program is under constant review for updating of the specifications, and changes may result frequently.

— The application is being designed and programmed centrally for a decentralized system that employs computers of different makes, models and configurations.

— The program will or might be run on equipment other than that for which the program is initially written.

— The program is to be understood and maintained by programmers other than the original ones.

— The advantages of improved program design, debugging, documentation and intelligibility can be obtained through the use of this high level language regardless of interchange potential.

— The program is or is likely to be used by organizations outside the Federal Government (i.e., State and local governments, and others).

— The program is being used for "cooperative" processing across multiple processing platforms (e.g., desktops, servers, and mainframes).

c. Nonstandard language features should be used only when the needed operation or function cannot reasonably be implemented with the portable features alone. Although nonstandard language features can be very useful, it should be recognized that their use may make the interchange of programs and future conversion to a revised standard or replacement processor more difficult and costly.

d. It is recognized that programmatic requirements may be more economically and efficiently satisfied through the use of statistical and numerical software packages. The use of any facility should be considered in the context of system life, system cost, data integrity, and the potential for data sharing.

e. Programmatic requirements may be also more economically and efficiently satisfied by the use of automatic program generators. However, if the final output of a program generator is a C source program, then the resulting program should conform to the conditions and specifications of FIPS C.

10. Specifications. FIPS C specifications are the language specifications contained in American National Standard for C, ANSI X3.159-1989.

a. The ANSI X3.159-1989 document specifies the representation, syntax, and semantics for C programs; the representation of input and output data processed by C programs; and the restrictions and limitations imposed by a conforming implementation of C.

b.   The standard does not specify the mechanisms by which C programs are transformed or invoked for use by a data processing system, the mechanisms by which input data are transformed for use by a C program or output data are transformed after being produced by a C program, the limits on program size or complexity, nor all minimal requirements of a data processing system that is capable of supporting a conforming implementation.

c.   A facility must be available in the processor for the user to optionally specify monitoring of the source program at compile time. The monitoring may be specified for all obsolete language elements included in the processor, or all C language elements that are not in conformance with this standard, or both. The monitoring is an analysis of the syntax used in the source program against the syntax included in the FIPS C. Any syntax used in the source program that does not conform to that included in this standard will be diagnosed and identified to the user through a message on the source program listing. Any syntax for an obsolete language element included in the processor and used in the source program will also be diagnosed and identified through a message on the source program listing. The determination of the need to flag any given source program syntax in accordance with these requirements cannot be logically resolved until the syntactic correctness of the source program has been established. The message provided will identify:

– The statement or declaration that directly contains the nonconforming or obsolete syntax.

– The source program line and an indication of the beginning of the location within the line of the statement or declaration which contains the nonconforming or obsolete code.

– The syntax as "obsolete" if monitoring is selected for the obsolete category.

– The syntax as "nonconforming nonstandard" if the nonconforming syntax is a nonstandard extension included in the processor and monitoring for all C language elements that are not in conformance with this standard is selected.

11.   Implementation.   The implementation of this standard involves three areas of consideration: acquisition of C processors, interpretation of FIPS C, and validation of C processors.

11.1   Acquisition of C Processors.   This publication is effective September 30, 1991. C processors acquired for Federal use after this date should implement FIPS C. Conformance to FIPS C is applicable whether C processors are developed internally, acquired as part of an ADP system procurement, acquired by separate procurement, used under an ADP leasing arrangement, or specified for use in contracts for programming services.

A transition period provides time for industry to produce C processors conforming to the standard. The transition period begins on the effective date and continues for one year thereafter. The provisions of FIPS PUB 160 apply to orders placed after the effective date of this publication; however, a processor conforming to the FIPS PUB 160, if available, may be acquired for use prior to the effective date. If a conforming processor is not available a C language processor not conforming to this standard may be acquired for interim use during the transition period.

11.2   Interpretation of FIPS C.   NIST provides for the resolution of questions regarding FIPS C specifications and requirements, and issues official interpretation as needed. All questions about the interpretation of FIPS C should be addressed to:

Director
Computer Systems Laboratory
ATTN: FIPS C Interpretation
National Institute of Standards and Technology
Gaithersburg, MD 20899
Telephone: (301) 975-3156

11.3 Validation of C Processors. The National Institute of Standards and Technology is investigating methods for providing validation services for FIPS C. For more information, contact:

Director
Computer Systems Laboratory
ATTN: FIPS C Validation
National Institute of Standards and Technology
Gaithersburg, MD 20899
Telephone: (301) 975-3156

12. Waivers. Under certain exceptional circumstances, the heads of Federal departments and agencies may approve waivers to Federal Information Processing Standards (FIPS). The head of such agency may redelegate such authority only to a senior official designated pursuant to section 3506(b) of Title 44, U.S. Code. Waivers shall be granted only when:

  a. Compliance with a standard would adversely affect the accomplishment of the mission of an operator of a Federal computer system, or

  b. Cause a major adverse financial impact on the operator which is not offset by Governmentwide savings.

Agency heads may act upon a written waiver request containing the information detailed above. Agency heads may also act without a written waiver request when they determine that conditions for meeting the standard cannot be met. Agency heads may approve waivers only by a written decision which explains the basis on which the agency head made the required finding(s). A copy of each such decision, with procurement sensitive or classified portions clearly identified, shall be sent to: National Institute of Standards and Technology; ATTN: FIPS Waiver Decisions, Technology Building, Room B-154; Gaithersburg, MD 20899.
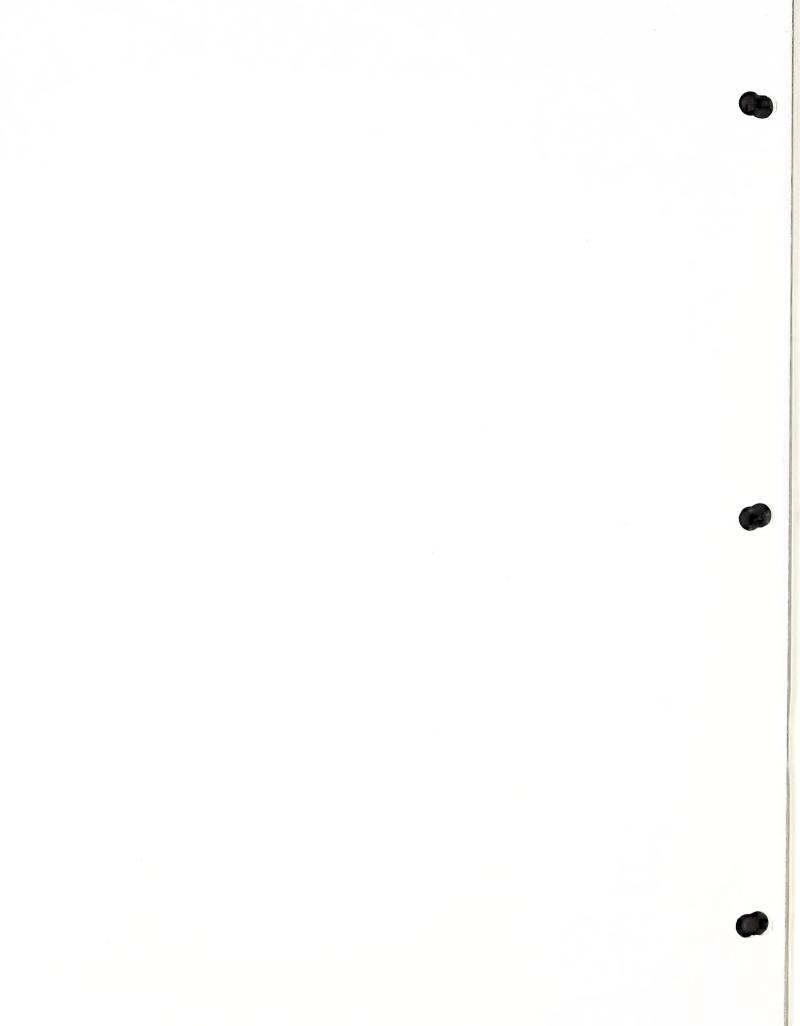
In addition, notice of each waiver granted and each delegation of authority to approve waivers shall be sent promptly to the Committee on Government Operations of the House of Representatives and the Committee on Governmental Affairs of the Senate and shall be published promptly in the *Federal Register*.
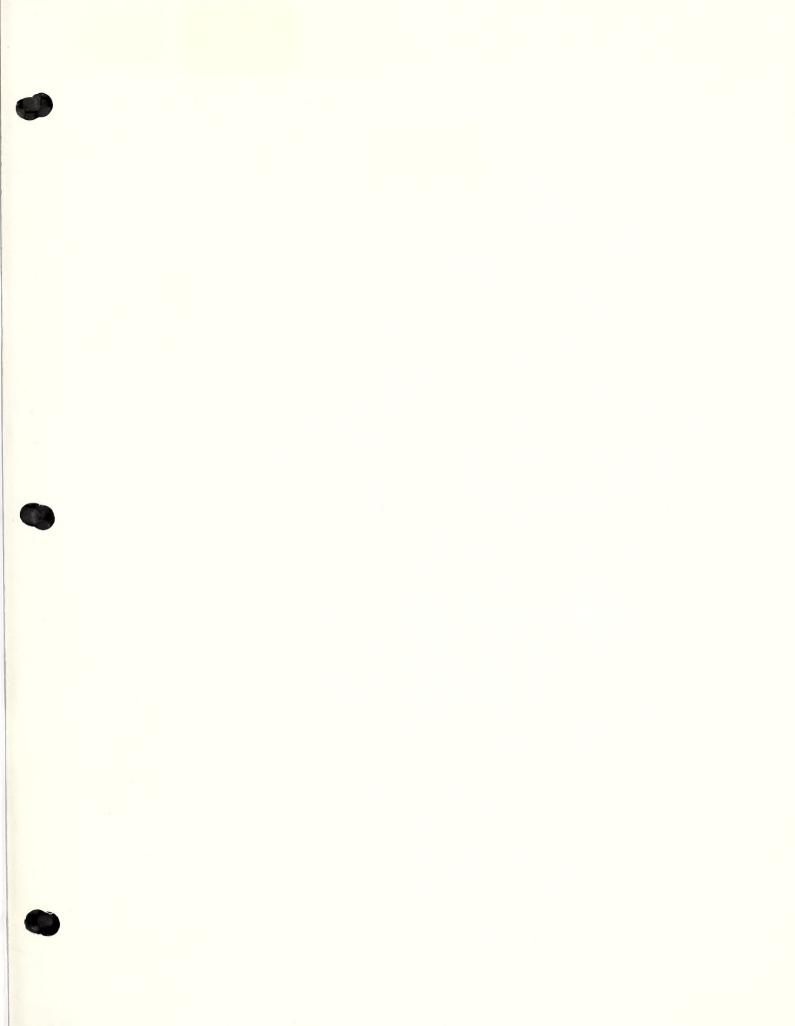
When the determination on a waiver applies to the procurement of equipment and/or services, a notice of the waiver determination must be published in the *Commerce Business Daily* as a part of the notice of solicitation for offers of an acquisition or, if the waiver determination is made after that notice is published, by amendment to such notice.

A copy of the waiver, any supporting documents, the document approving the waiver and any supporting and accompanying documents, with such deletions as the agency is authorized and decides to make under 5 U.S.C. Sec. 552(b), shall be part of the procurement documentation and retained by the agency.

13. Where to Obtain Copies. Copies of this publication are for sale by the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161. (Sale of the included specifications document is by arrangement with the American National Standards Institute.) When ordering, refer to Federal Information Processing Standards Publication 160 (FIPSPUB160), and title. Payment may be made by check, money order, or deposit account.